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EXAMINER
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HOFFMAN, JOANNE M

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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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*Ex parte* BLAISE FREDERICK and YUNJIE TONG

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Appeal 2017-001651  
Application 13/701,567  
Technology Center 3700

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Before JEFFREY N. FREDMAN, JOHN E. SCHNEIDER, and  
KRISTI L. R. SAWERT, *Administrative Patent Judges*.

FREDMAN, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal<sup>1</sup> under 35 U.S.C. § 134 involving claims to a computer-implemented method for measuring at least one of blood flow or volume in a subject. The Examiner rejected the claims as lacking patent utility and as obvious. We have jurisdiction under 35 U.S.C. § 6(b). We reverse.

*Statement of the Case*

*Background*

“Measuring blood flow in organs is useful in a variety of diagnostic and therapeutic procedures. Magnetic resonance imaging (MRI) can be used for such measurements” (Spec. 1).

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<sup>1</sup> Appellants identify the Real Party in Interest as the McLean Hospital Corporation (*see* App. Br. 1).

Blood oxygenation level-dependent functional MRI (BOLD fMRI) reflects changes in local blood oxygenation levels and volume in various parts of an organ. On the other hand, near-infrared spectroscopy (NIRS) is an imaging modality that tracks temporal changes in oxygenation and total hemoglobin level at a given portion of the body.

(*Id.* at 2). The “invention is based, at least in part, on the discovery that patterns of oxygenation and total hemoglobin detected using NIRS can be matched with a BOLD fMRI pattern in an area of interest . . . . This information can be used to map blood flow through the organ” (*id.* at 2).

#### *The Claims*

Claims 37–47 and 54–56 are on appeal. Independent claim 37 is representative and reads as follows:

37. A computer-implemented method for measuring at least one of blood flow or volume in a subject, the method comprising:

receiving functional magnetic resonance imaging (fMRI) data that provides information on at least one of volume or oxygenation of blood at one or more locations in a body over a first predetermined length of time;

receiving spectroscopic measurement data representing at least one of blood concentration or oxygenation at a first portion of the body over a second predetermined length of time;

deriving, from the fMRI data corresponding to a second portion of the body, a time varying data set representing changes in at least one of blood oxygenation or volume at a second portion of the body over the first predetermined length of time;

determining a time delay and a value of a similarity metric corresponding to a part of the spectroscopic imaging data that most closely matches the time varying data set, the

time delay representing a difference between a first time in which blood flows from a third portion in the body to the first portion and a second time in which blood flows to the second portion from the third portion, and the value of the similarity metric representing an amount of blood at the second portion; and

determining, based on the time delay and the value of the similarity metric, an estimate of a characteristic of at least one of blood flow or blood volume in the second portion at a given time.

### *The Issues*

- A. The Examiner rejected claims 37, 38, 40, 47, and 54 under 35 U.S.C. § 103(a) as obvious over Huppert<sup>2</sup> and Gupta<sup>3</sup> (Final Act. 6–10).
- B. The Examiner rejected claim 39 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Bryskhe<sup>4</sup> (Final Act. 10).
- C. The Examiner rejected claims 41–44, 46, 55, and 56 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Sassaroli<sup>5</sup> (Final Act. 10–13).
- D. The Examiner rejected claim 45 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Dan<sup>6</sup> (Final Act. 13–14).

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<sup>2</sup> Huppert et al., *A temporal comparison of BOLD, ASL, and NIRS hemodynamic responses to motor stimuli in adult humans*, 29 NEUROIMAGE 368–82 (2006).

<sup>3</sup> Gupta et al., *Dynamic programming based time-delay estimation technique for analysis of time-varying time-delay*, 81 REV. SCIENTIFIC INSTRUMENTS 1–8 (2010).

<sup>4</sup> Bryskhe et al., WO 2008/147326 A1, published Dec. 4, 2008.

<sup>5</sup> Sassaroli et al., *Spatially weighted BOLD signal for comparison of functional magnetic resonance imaging and near-infrared imaging of the brain*, 33 NEUROIMAGE 505–14 (2006).

E. The Examiner rejected claims 37–47 and 54–56 under 35 U.S.C. § 101 as lacking patentable subject matter (Final Act. 5–6).

*A. 35 U.S.C. § 103(a) over Huppert and Gupta*

The issue with respect to this rejection is: Does the evidence of record support the Examiner’s conclusion that Huppert and Gupta suggest “determining, based on the time delay and the value of the similarity metric, an estimate of a characteristic of at least one of blood flow or blood volume” using fMRI and spectroscopic data as required by claim 37?

*Findings of Fact*

1. Huppert teaches performing “simultaneous near-infrared spectroscopy (NIRS) along with BOLD (blood oxygen level dependent) and ASL (arterial spin labeling)-based fMRI during an event-related motor activity in human subjects in order to compare the temporal dynamics of the hemodynamic responses recorded in each method” (Huppert 368, Abstract)

2. Huppert teaches the each fMRI “run lasted 6 min and consisted of between 27 and 32 stimulus periods. This was repeated 4–6 times for each subject during the course of one scan session (approximately 90 min) for both the ASL and BOLD measurements” (Huppert 370, col. 1).

3. Huppert teaches that for NIRS, “[e]poch timing was synchronized to the MRI images so that subject response times were kept constant between the fMRI and NIRS” (Huppert 371, col. 1).

4. Huppert teaches that using NIRS “concentration data, the individual subject hemodynamic responses were calculated using an

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<sup>6</sup> Dan et al., US 2007/0282189 A1, published Dec. 6, 2007.

ordinary least-squares (OLS) linear deconvolution and implemented within the HomER program” (Huppert 371, col. 1).

5. The Examiner acknowledges “Huppert does not teach explicitly . . . a time delay and the time delay representing a difference between a first time and a second time” (Final Act. 7).

6. Gupta teaches “beam emission spectroscopy (BES) diagnostic in fusion plasmas has not only provided the measurements and understanding of plasma turbulence but has also served as a tool to measure and study the local magnetic field and beam-plasma interactions” (Gupta 1, col. 1).

7. Gupta teaches for beam emission spectroscopy diagnostic in fusion plasmas “spatially separated time-series signals of density fluctuations serve as carrier signals for the measurement of time-varying time-delay” (Gupta 1, col. 2).

8. Gupta teaches the “technique will continue to provide useful information in the field of plasma turbulence, and it can certainly be extended to other branches of physics and science” (Gupta 8).

*Principles of Law*

“Prior art is analogous if it is from the same field of endeavor or if it is reasonably pertinent to the particular problem the inventor is trying to solve.” *Circuit Check Inc. v. QXQ Inc.*, 795 F.3d 1331, 1335 (Fed. Cir. 2015). “The question is not whether simple concepts . . . are within the knowledge of lay people or even within the knowledge of a person of ordinary skill in the art. Rather, the question is whether an inventor would look to this particular art to solve the particular problem at hand.” *Id.*

*Analysis*

Appellants contend

*Gupta* constitutes non-analogous art. That is, the Examiner provided no basis to explain why one of ordinary skill in the art would stray from *Huppert*'s focus on comparing medical imaging information into a reference, *Gupta*, that is focused on measuring the poloidal velocity fluctuation in high temperature tokamak plasmas using beam-emission-spectroscopy diagnostic.

(App. Br. 23).

The Examiner responds “the [Gupta] reference is solving a similar problem by using mathematics to develop a time-delay estimation. A time-delay is common in many arts and using mathematics based on signals is analogous art. And therefore these can be combine[d]” (Ans. 17). The Examiner finds the “mathematical technique can be applied to the time-delay for fMRI and NIRS as both are just signal processing and understanding how signals interact and work within data and with hardware and fluid moving” (Ans. 18).

We agree with Appellants that Gupta, drawn to analysis of plasmas associated with the physics of nuclear fusion is neither in the same field of endeavor as Huppert, nor pertinent to problems with which the Specification or Huppert were concerned (*see* App. Br. 23).

In particular, the Specification teaches: “Matching the fMRI data with the NIRS data involves deriving a time course from the fMRI data of a particular portion . . . of the body part and determining if one or both of the oxygenation and volume fluctuations in any part” (Spec. 15). The Specification explains “the shape of the time course can represent a global

blood oxygenation pattern that travels through the entire organ” (Spec. 16). The Specification teaches that “the methods and systems described herein can be used for assessing frontal and/or temporal lobe perfusion in suspected Alzheimer’s disease” as well as “determining regions of ischemia and/or bleeding in the brain in stroke patients” (Spec. 23). Thus, the problem with which the Specification was concerned was to determine how changes in oxygenation in human organs impact disease.

While Huppert is associated with blood oxygen levels (FF 1), Gupta is entirely unrelated to any sort of biological or even chemical analysis but rather is generally drawn to understanding of plasma turbulence in nuclear fusion plasmas (FF 6).

When considering whether a reference is pertinent to the problem with which the inventor or prior art were concerned, the framing of the problem may well be determinative of the analogous art determination. If the problem is broadly framed as the desire to perform signal analysis generally, then Gupta has some degree of relevance generally to any signal analysis process. However, this broad a framing is unreasonable, because under this logic any reference dealing with a general concern will always be pertinent.

When the problem is framed at a more reasonable scale, whether narrowly as comparing the temporal dynamics of the hemodynamic response as Huppert suggests (FF 1), or more broadly as measuring the flow of a fluid in a biological subject, Gupta lacks any indicia of relevance to these fields of endeavor.

We are not persuaded by the Examiner’s finding that Gupta’s “mathematical technique can be applied to the time-delay for fMRI and



NIRS as both are just signal processing and understanding how signals interact and work within data and with hardware and fluid moving” (Ans. 18). Certainly Gupta teaches time delay mathematical techniques (FF 7), but Gupta is not analogous art that provides reasons for applying these time-delay mathematical techniques into the medical process disclosed by Huppert. Indeed, even in Gupta’s broad conclusion, Gupta focuses on extending the techniques “to other branches of physics and science” (FF 8) generally, without providing any reason why the techniques would be pertinent to analysis of biological data such as fMRI or NIRS.

*Conclusion of Law*

The evidence of record does not support the Examiner’s conclusion that Huppert and Gupta suggest “determining, based on the time delay and the value of the similarity metric, an estimate of a characteristic of at least one of blood flow or blood volume” using fMRI and spectroscopic data as required by claim 37.

*B.–D. 35 U.S.C. § 103(a)*

The Examiner relies upon Gupta for each of these rejections to teach the time delay analysis limitation of independent claim 37 (*see* Final Act. 10–13). Having reversed the obviousness rejection of claim 37 over Huppert and Gupta because Gupta is not analogous art for the reasons given above, we also find that the further combinations with Bryskhe, Sassaroli, and Dan do not render the rejected claims obvious for the same reason.

*E. 35 U.S.C. § 101*

The Examiner finds all of the claims on appeal unpatentable under 35 U.S.C. § 101 as being directed to patent-ineligible subject matter, specifically the abstract “idea of data matching the natural phenomenon of blood oxygenation/hemoglobin volume/concentration, which is a mathematical algorithm/relationship fundamental in the practice of the art of image analysis/modeling” (Final Act. 5). The Examiner finds the “claim elements such as the data acquisition and manipulation . . . do not provide meaningful limitations to transform the abstract idea into a patent eligible application of the abstract idea” (*id.*).

To determine whether a claim is invalid under § 101, we employ the two-step *Alice* framework. In step one, we ask whether the claims are directed to a patent ineligible concept, such as an abstract idea or law of nature. *Alice Corp. Pty. Ltd. v. CLS Bank Int’l*, 134 S. Ct. 2347, 2355 (2014); *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*, 566 U.S. 66, 75–77 (2012); *Ariosa Diagnostics, Inc. v. Sequenom, Inc.*, 788 F.3d 1371, 1375 (Fed. Cir. 2015). While both method and computer readable media claims are generally eligible subject matter, claims that are directed only to abstract ideas and/or natural phenomena are directed to a patent ineligible concept. *Ariosa*, 788 F.3d at 1376.

#### *Alice Step One*

Claim 37 of the instant application is directed to a method for measuring blood flow or volume by analyzing data obtained by both fMRI and spectroscopy that is then analyzed using two mathematical parameters,

time delay and similarity metric. Claim 54 is a computer readable medium incorporating the method of claim 37.

Taking up the first step of the patent-eligibility analysis, we note, “[a]t some level, ‘all inventions . . . embody, use, reflect, rest upon, or apply laws of nature, natural phenomena, or abstract ideas,’” and whether one takes a macroscopic or microscopic view of a claim may be determinative on the issue. *Alice*, 134 S. Ct. at 2354. While “a mathematical formula like the Arrhenius equation is not itself patent-eligible subject matter, even if limited to a particular technological environment,” claims are patent eligible under § 101 “when a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect.” *Diamond v. Diehr*, 450 U.S. 175, 191–2 (1981).

Claims 37 and 54 are closely analogous to claim 22 in *Thales Visionix Inc. v. United States*, 850 F.3d 1343 (Fed. Cir. 2017), which involved determining an object’s orientation relative to a moving reference frame using two inertial sensor. *Id.* at 1345. Just as the method in *Thales* “utilize mathematical equations to determine the orientation of the object relative to the moving reference frame,” *id.* at 1348, in claim 37 “matching an fMRI time course and the NIRS signal is done by performing multiple general linear model fits using versions of the NIRS signal advanced or delayed in time” (Spec. 16). Both the *Thales* claims and the instant claims rely on mathematical operations in association with devices that obtain relevant information in a way that improves the accuracy of the underlying assay. *See Thales*, 850 F.3d at 1348; Spec. 16–18.

We therefore conclude that just as the *Thales* “claims seek to protect only the application of physics to the unconventional configuration of sensor,” *Thales*, 850 F.3d 1349, so too the instant claims seek to protect the application of physics to a unconventional combination of fMRI and NIRS signals to more accurately determine blood flow or volume. Therefore, these claims are not directed to an abstract idea and thus the claims survive *Alice* step one and are therefore patent eligible.

*Alice Step Two*

However, turning to the second step under *Alice*, we find the claims patent eligible even if we agreed with the Examiner that the claims simply relate to “a process that employs mathematical algorithms to manipulate existing information to generate additional information is not patent eligible.” *Digitech Image Techs., LLC v. Elecs. for Imaging, Inc.*, 758 F.3d 1344, 1351 (Fed. Cir. 2014).

The facts and claimed subject matter here are analogous to those of the recent Federal Circuit decision in *Amdocs (Israel) Ltd. v. Openet Telecom, Inc.*, 841 F.3d 1288 (Fed. Cir. 2016), which leads us to determine that the claims recite the “something more” required by the Supreme Court to transform an abstract idea into a patent-eligible invention. *See also Alice*, 134 S. Ct. at 2355. As in *Amdocs*, here, even if we conceded that claim 1 was directed to an abstract idea of analyzing data using mathematical algorithms, claims 37 and 54 entails unconventional technical solutions by combining fMRI and NIRS data in an approach that the Examiner has not shown to be anticipated or obvious. This solution addresses a technological problem (i.e., the difficulty in determining blood flow or volume without

resorting tags and prior art issues with “low sensitivity, low resolution, and a limitation on the duration of time that blood can be tracked due to loss of coherence of tagged blood”). *See* Spec. 1; *see also Amdocs*, 841 F.3d at 1301. As in *Amdocs*, claims 37 and 54 ties the invention to a structure -- “fMRI imaging” and “spectroscopic measurement” and, indirectly therefore, to MRI machines and spectrometers. *See* claim 37, *supra*; *see also Amdocs*, 841 F.3d at 1301. As in *Amdocs*, claims 37 and 54 are not drawn to preempt the generic enhancement of data in similar systems, but are directed to specific technological solutions needed for blood flow or volume analysis by combining fMRI and NIRS data. *See* claim 37, *supra*; *see also Amdocs*, 841 F.3d at 1301. Considered as an ordered combination, we are not persuaded that claims 37 and 54 recite an invention that is merely the routine or conventional use of technology previously known to skilled persons.<sup>7</sup>

We therefore conclude that Supreme Court and Federal Circuit precedent supports the conclusion that the claims on appeal are directed to patent-eligible subject matter.

#### SUMMARY

In summary, we reverse the rejection of claims 37, 38, 40, 47, and 54 under 35 U.S.C. § 103(a) as obvious over Huppert and Gupta.

We reverse the rejection of claim 39 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Bryskhe.

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<sup>7</sup> We note that our reversal of the obviousness rejection supports this position.

We reverse the rejection of claims 41–44, 46, 55, and 56 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Sassaroli.

We reverse the rejection of claim 45 under 35 U.S.C. § 103(a) as obvious over Huppert, Gupta, and Dan.

We reverse the rejection of claims 37–47 and 54–56 under 35 U.S.C. § 101 as lacking patentable subject matter.

REVERSED